



## GreenTech: Keeping it clean

We're seeing a transformative shift to a clean energy world, and with it the next normal. We explore four key drivers underpinning the GreenTech growth prospects.

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FOCUS ARTICLE  
**Hydrogen: More  
than just talk**



GLOBAL EQUITY  
**Gathering speed**



GLOBAL FIXED INCOME  
**The calm before the  
calm?**



KEY FORECASTS

For important and required non-U.S. analyst disclosures, see page 26.  
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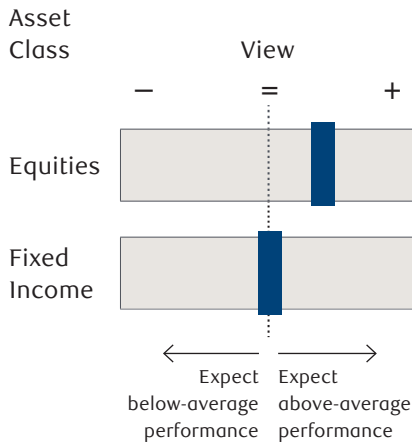
A flurry of positive economic data is unlikely to change accommodative central bank policy in the near term. And investor uncertainty around the direction of fiscal policy could provide additional temporary support to bond prices.

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# RBC'S INVESTMENT Stance

## Global asset class views



(+/-/-) represents the Global Portfolio Advisory Committee's (GPAC) view over a 12-month investment time horizon.

**+ Overweight** implies the potential for better-than-average performance for the asset class or for the region relative to other asset classes or regions.

**= Market Weight** implies the potential for average performance for the asset class or for the region relative to other asset classes or regions.

**- Underweight** implies the potential for below-average performance for the asset class or for the region relative to other asset classes or regions.

Source - RBC Wealth Management

## EQUITIES

- Major economies are in recovery mode, with the U.S. and China leading the way and Canada keeping pace with its southern neighbor. We expect Europe and the UK to pick up in the second half of the year as tourism begins to restart.
- Strong earnings momentum, robust consumer and business confidence, and ongoing accommodative monetary and fiscal policies combine to produce a constructive outlook for equities. Consolidation periods and corrections can arrive at any time, but any wobbles in the market should be transitory because the global and U.S. economies are in the early stages of recovery. The tight credit conditions necessary to produce the next recession, falling corporate earnings, and equity bear market look to be a long way off. We recommend maintaining a moderately Overweight position in equities.

## FIXED INCOME

- Global fixed income markets found themselves in two halves in April, as U.S. and developed Asian markets outperformed European sovereigns. The sharp rise in Treasury yields—and concerns on rising COVID-19 case counts—helped draw investors into U.S. government debt. For now, we think global yields can move modestly higher as growth and reflation themes gain steam. We favor shorter maturities in government debt, although we see emerging value in longer maturities, particularly in the U.S. In credit markets, valuations are historically rich and corporate bond yields remain near record lows, but we still expect credit to outperform government debt in 2021.
- We maintain our Market Weight in global fixed income and maintain moderately low interest rate risk exposure as global yields rise on a continued repricing of a strong economic recovery. We maintain a modest Overweight to corporate credit, primarily via preferred shares.

## MONTHLY Focus



**Frédérique Carrier**  
London, UK  
frederique.carrier@rbc.com

# GreenTech: Keeping it clean

Once, the green technologies theme was a niche that was “nice to have.” Now, we’re seeing a transformative shift to a clean energy world, and with it the next normal. We explore four key drivers underpinning the GreenTech growth prospects. Companies developing environmentally-friendly technologies present interesting long-term investment opportunities, in our view.

### A profound energy transition

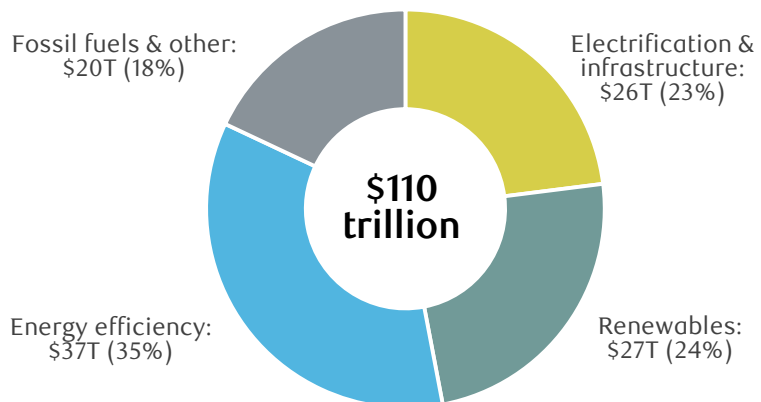
The world is in the midst of a transformative shift toward renewable energy. This transition will be more rapid and potentially more profound than the adoption of oil in the 1850s. In that instance, it took a century from the time commercial oil wells were first drilled for oil to account for a quarter of the energy used worldwide. Today’s goal is to achieve the bulk of this energy transition by 2050, or over just three decades, in line with the Paris Agreement’s aim to keep global warming to well below 2 degrees Celsius compared to pre-industrial levels.

A considerable share of the energy currently produced from fossil fuels will need to be replaced by energy from renewable sources, remembering that demand for electricity will go on rising from current levels as the world population grows and many activities, such as transport, become increasingly electrified.

In short, the energy transition requires that within a few decades, the way energy is *produced, stored, transmitted, and consumed* will need to change.

According to IRENA, the International Renewable Energy Agency, an intergovernmental organisation that supports countries in their transition to greater reliance on sustainable energy, \$110 trillion will need to be invested over the next 30 years to realise the global energy transformation.

### Cumulative investments needed for energy transition



Note: Fossil fuels = mostly oil, natural gas, coal  
Source - IRENA

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A wide range of industries are needed to make the energy transition a reality.

Importantly, this transformative investment is being driven by a government policy roadmap that is synchronised for the first time, with 2020 marking a turning point:

- The European Green Deal refocused the EU’s COVID-19 stimulus package onto renewables—charging infrastructure, power generation, and green hydrogen projects, allocating up to \$600 billion to green projects.
- China’s 14th Five-Year Plan called for electric vehicles (EVs) to constitute 20 percent of overall new car sales in China by 2025 from just five percent now and to reduce its dependence on coal (spending up to 10 trillion yuan, or \$1.5 trillion).
- Joe Biden won the U.S. presidential election, with a sweeping infrastructure programme (up to \$2 trillion) one of his key initiatives.

### Some industries set to benefit from the energy transition

| Transformation              | Industry   |
|-----------------------------|--|
| Renewables                  | <ul style="list-style-type: none"> <li>• Independent wind farm operators</li> <li>• Wind turbine manufacturers</li> <li>• Utility companies with expertise in renewable power</li> <li>• Solar panel equipment manufacturers</li> <li>• Enablers (semiconductor manufacturers)</li> <li>• Software/enablers</li> <li>• Monitoring systems</li> </ul> |
| Energy storage              | <ul style="list-style-type: none"> <li>• Battery systems operators</li> <li>• Battery manufacturers</li> </ul>   |
| Transmission & distribution | <ul style="list-style-type: none"> <li>• Transmission systems managers</li> <li>• Electric cable manufacturers</li> <li>• Power equipment manufacturers (e.g., substations, transformers)</li> <li>• Electricity distribution companies</li> </ul>   |
| Electric vehicles           | <ul style="list-style-type: none"> <li>• Manufacturers and operators of charging infrastructure</li> <li>• Parts manufacturers</li> </ul>  |

Source - RBC Wealth Management

### Transformation #1: The way energy is produced

As we noted in our [climate change report](#) in March, energy used in industry, transport, and buildings is responsible for some three-quarters of all greenhouse gas emissions. At the moment, fossil fuels (mostly oil, natural gas, and coal) are burned to produce electricity, creating carbon emissions in the process. One way to reduce emissions is to shift to electricity generated by wind turbines, solar panels, and other renewables. Hydropower is already being used as much as it likely can: not all countries have the water resources necessary, and those that do have already developed them as much as possible over the past 100 years.

The International Energy Agency (IEA) projects that renewables will account for 95 percent of the net increase in global power capacity through 2025. It points out that solar and onshore wind, for which costs have fallen dramatically over the past two decades, are already the cheapest ways of adding new electricity-generating capacity in most countries. The IEA

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expects solar alone to account for 60 percent of all renewable capacity additions through 2025, with wind providing another 30 percent. Within the latter, offshore wind is expected to see the most growth, driven by further cost declines and a move beyond Europe/UK, where it is already a major factor, to new markets such as China and the U.S. where ample potential remains.

### Various countries' renewable energy situation

They are all making an effort

|                       | Electricity production 2020 |       |       | Comment   |
|-----------------------|-----------------------------|-------|-------|---|
|                       | Wind                        | Solar | Hydro |   |
| <b>China</b>          | 5%                          | 3%    | 17%   | China boasts the world's largest renewables sector and produces close to three-quarters of the world's solar modules, two-thirds of its lithium-ion batteries, and close to half of its wind turbines. It also controls the global supply of cobalt and lithium, key elements used in battery storage. China is currently the world's largest greenhouse gas emitter, but plans to increase its renewables capacity by 40% between 2020 and 2025.   |
| <b>European Union</b> | 15%                         | 5%    | 13%   | In 2000, Germany was the first EU country to announce it would start to move away from fossil fuels, creating the conditions for European industry to develop a global edge in renewables technology. Many of Europe's largest utility companies have now transformed themselves into energy transition pioneers, building wind and solar farms and investing in grids around the world. The EU has continued to lead the way in the energy transition by linking its COVID-19 crisis fiscal response to the goal of achieving a greener economy. Plans to redesign the EU's electricity markets should enable further progress.  |
| <b>U.S.</b>           | 8%                          | 2%    | 7%    | The U.S. has lagged others so far, as it focused on shale oil and gas to become the world's largest oil producer. President Biden is now focusing on decarbonising the U.S. economy. His \$2 trillion infrastructure package would be the most ambitious in decades. It includes some \$175 billion for electric vehicle tax credits and charging stations, \$100 billion to upgrade the country's electric grid, and a similar amount to retrofit residential and institutional buildings.   |
| <b>Canada</b>         | 5%                          | 0%    | 60%   | Historically, Canada has focused on hydroelectricity given its abundant water resources. Alberta also has a well-developed oil sands industry, but given the high cost of extraction combined with relatively weak oil prices over the past six years, the region is exploring new technologies. Benefiting from the province's wealth of geological resources, the Alberta government is actively encouraging the development of geothermal energy, as well as the production of hydrogen. It is also looking to foster the extraction of minerals used in the production of batteries.  |
| <b>UK</b>             | 25%                         | 2%    | 2%    | Over the past decades, the UK has completely eradicated its reliance on coal, replacing it with natural gas and renewables, thereby cutting carbon emissions faster than other developed countries. The UK boasts the largest offshore wind farm in the world with more than 170 turbines across 400 km <sup>2</sup> (however, China has a project on track to surpass this in the next decade). To achieve a green economy, the UK's next step is to reduce its reliance on natural gas. Decarbonisation efforts seem to have slipped in recent years and the political consensus on this issue has weakened. The government's "Green Industrial Revolution" announcement last December aims to redress the situation. The UK is hosting the UN's climate change summit, known as COP26, in November 2021, which will give it the opportunity to reassert its position as a global climate leader. |

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While wind and solar will likely play the largest role in the low-carbon economy, other technologies will also feature:

- **Nuclear:** Produces no greenhouse gas emissions, though the manufacturing of the equipment and the construction of the station most probably do
- **Carbon capture:** Removes carbon dioxide from the atmosphere or directly from industrial processes and injects it into deep underground geological formations (known as “sequestration”)
- **Hydrogen:** As a way to store solar and wind energy to be used when needed and as a direct substitute for fossil fuels including coking coal (for more see “Hydrogen: More than just talk” on [page 11](#))
- **Geoexchange:** Takes advantage of the fairly constant temperatures a few metres below the earth’s surface to heat homes and buildings in the winter and cool them in the summer using heat pumps
- **Waste heat recovery:** Captures the waste heat from buildings and industrial processes and converts it into electricity via thermoelectric generators

The energy transition has forced oil and gas companies to invest in renewables. European majors are leading the way. Royal Dutch Shell even links executive pay to the progress it makes in reducing emissions. U.S. Big Oil has been more reticent, though these companies are starting to take some steps. The global energy majors can be part of the solution, reinvesting part of their substantial free cash flow to help fund their transition aims. The risk, in our view, is that they overpay for renewables projects.

### Transformation #2: The way energy is stored

One major challenge for renewables is the disconnect between the continuous nature of electricity demand and the intermittency of solar and wind power. The sun doesn’t always shine and the wind doesn’t always blow. Worse, storms can make a wind farm inoperable.

This can be dealt with by adding an energy source that runs only when needed—though these usually produce some harmful emissions and are costly to run if only used part-time.

Battery energy storage systems, which can store energy during periods of excess and discharge it during shortages, are another solution. These can be stationary or modular, industrial-size batteries installed at various points of the electric grid to support grid management. They are a critical component in an increasingly renewable-reliant grid.

Storage costs are coming down thanks to innovation and economies of scale. According to Shelby Tucker, RBC Capital Markets, LLC Utilities Analyst, storage system unit costs are expected to decline by 45 percent by 2030 and by 59 percent by 2050, while the next-generation battery technologies, some offering more than double the energy capacity of standard lithium-ion batteries, may drive down costs even further. Tucker believes the global market for batteries has the potential to grow 100 times by 2050.

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Battery technology can also be key to the uptake of EVs. Reducing the battery cost is important in making EVs more price competitive as batteries represent as much as 30 percent of the cost of an EV. Already down by more than 85 percent over the past decade, it needs to fall further. The average cost of a lithium-ion battery pack is currently just under \$140 per kilowatt-hour (kWh). According to BloombergNEF, EVs become cost competitive compared to traditional cars at \$100 per kWh, which appears to be achievable by 2023, with some producers reporting costs below \$100 for the first time.

Importantly, battery range, efficiency, and speed of recharging should also improve thanks to innovation and investment. Volkswagen recently committed to reducing battery costs by up to half and producing long-range and fast-charging batteries from 2024.

Hydroelectric power can act as a very large-scale battery. In Canada, Quebec recently green-lighted a large wind power project made feasible by the ability to use the province's massive hydro capacity as a back-up when wind power falters. Likewise, Alberta's extensive wind and solar potential could be much more fully developed if backed-up by neighbouring British Columbia's extensive hydroelectric resources. What's missing is a more integrated grid system along their 1,800 km border.

### **Transformation #3: The way energy is transported**

Because solar panels and wind turbines are installed where the sun shines and the wind is blustery, and not necessarily near cities, the current transmission model based on power plants sending electricity to nearby cities is not viable.

To transport solar- and wind-generated electricity, high-voltage transmission is needed over large distances. In the U.S., as in many other places, this is an issue because the transmission system is highly fragmented and doesn't easily send electricity from one end of the country to the other.

High-voltage transmission systems are under development, but this is a complex undertaking with several stakeholders including landowners and state and local governments. One example is the TransWest Express, a high-voltage electric grid designed to move three gigawatts (GW) of wind power generated in windy Wyoming to California. Construction is finally about to start, 17 long years after planning began.

China has been building out its ultra-high-voltage transmission network since 2009 to accommodate surging electricity consumption and various power resources. By the end of 2020, it had constructed 30 networks to transmit electricity from the its interior to the populated coastal regions in Eastern and Southern China.

Power distribution systems, which connect power lines to homes, will also need to be upgraded to accommodate higher electricity demand as reliance on fossil fuels in the home decreases while electricity consumption increases. For instance, according to the U.S. Federal Highway Administration, an EV uses 4,000 kWh of electricity per year to



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operate, assuming 13,500 miles driven—admittedly, a long distance by European standards. By comparison, the average U.S. household consumes 11,000 kWh per year, so having an EV would increase consumption by one-third in the U.S.

### Transformation #4: The way energy is used

Despite buzz for years about EVs, such cars were a mere three percent of global demand in 2020, though with stark regional differences. Still-prohibitive prices, inadequate battery ranges, and a lack of public and home charging infrastructure have all stunted the uptake.

#### Global electric vehicle demand forecast

Western Europe leads, China is catching up

|                | EV as % of total vehicle demand |       |       | % of vehicles in operation 2050 |
|----------------|---------------------------------|-------|-------|---------------------------------|
|                | 2020                            | 2025E | 2050E |                                 |
| U.S.           | 2%                              | 7%    | 80%   | 44%                             |
| China          | 4%                              | 18%   | 95%   | 57%                             |
| Western Europe | 6%                              | 20%   | 95%   | 63%                             |
| Global         | 3%                              | 11%   | 83%   | 46%                             |

Source - RBC Capital Markets

But this appears about to change. RBC Capital Markets, LLC U.S. Auto Analyst Joseph Spak forecasts EVs will represent 11 percent of demand for new cars by 2025, with growth rates of some 40 percent per year, supported by regulations to phase out internal combustion engine vehicles. To date, at least 24 countries have proposed some form of zero-emission vehicle targets. For instance, the UK will ban the sale of new petrol and diesel cars from 2030.

Meanwhile, President Biden's infrastructure plan proposes allocating some \$175 billion to EVs in the form of tax credits to consumers and incentives to build 500,000 public charging stations.

Manufacturers are in the early stages of a heavy investment and capital expenditure cycle to dramatically boost the production of EVs and develop the related software. Many are planning to ramp up EV capacity, and to offer a wider range of price points and models. General Motors is accelerating its EV plans by spending \$27 billion over the next five years on electric and autonomous vehicles. It aims to deliver more than one million EVs by 2025 and to stop making gasoline-powered cars by 2035. Ford's legacy internal combustion engine vehicles should also transition to EVs, though at a slower pace than at GM. Chinese car manufacturers are also ramping up EV production. Zhejiang Geely Holding, one of China's biggest automakers and owner of Volvo Cars, launched a luxury EV brand, called Zeekr. A growing number of startups also are eyeing the country's booming EV market. Li Auto is aiming to be the No. 1 smart EV maker in China, and is targeting 20 percent market share in China by 2025.

The transition from internal combustion engines to EVs has been compared to that from horses to cars. It may not be an exaggeration. The change goes much beyond altering assembly lines. EVs are increasingly becoming more like smartphones, with wireless transmission of software updates.

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Getting this digitalisation right is key, as software opens up new opportunities for recurring and post-sale revenues via digital upgrades and increased customer connectivity. Volkswagen is spending €27 billion over the next five years on software, artificial intelligence, and autonomous vehicles, aiming to increase the share of its own software used in its cars from currently 10 percent to 60 percent. Like others, it is opting to keep new technologies in-house to learn how to optimise technology and costs.

Spak points out that investors have generally cheered this step-up in investment as it improves companies' future prospects. But they will likely want to see proof of better returns on these investments and of EVs as a platform with more recurring revenue opportunities, a larger addressable market, and less cyclicity. For traditional automakers undergoing this metamorphosis, investor enthusiasm should be tempered by the possibility of write-downs of legacy manufacturing footprints, restructurings, labour concerns, and culture change.

Parts suppliers will also need to navigate a swift transition. Spak believes those that can show a path to stronger earnings power in an EV world should see their valuations re-rate higher—or at least sustain their recent increases in valuation. Should current levels of profitability be merely maintained or even decrease, a higher valuation would be harder to justify, in his view.

### **A pause that has refreshed?**

GreenTech stocks have lost some ground so far this year, as the market has rotated into stocks that will likely benefit from the economic reopening. A useful gauge is the MSCI Global Alternative Energy Index, which tracks companies that derive 50 percent or more of revenues from operations that contribute to a more environmentally sustainable economy. The index lost close to 30 percent of its value between early January and early March this year. To be sure, this followed a 220 percent gain from the trough of March 2020 to the index's January peak (versus the MSCI World Index's gain of 71 percent over the same period). After the recent correction, the index's relative price-to-earnings ratio is the lowest it has been in four years. Despite the strong gains last year, the recent volatility represents a good opportunity, in our view, to build exposure to these long-term, secular themes.

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MONTHLY  
Focus



**Kelly Bogdanova**  
San Francisco, United States  
kelly.bogdanova@rbc.com

## Hydrogen: More than just talk

Hydrogen is the lightest of all elements, but it has the potential to be a heavyweight in the transition to clean energy. Startups and seasoned corporations in a variety of sectors are already committing to innovative hydrogen applications, and governments are setting ambitious goals. It won't be a one-size-fits-all transition. There will be—and should be—regional differences in the uses and export of hydrogen, especially in the early years. The report takes a closer look at hydrogen's global potential, including untapped opportunities for its use in a variety of industries.

### Five things investors should know about hydrogen's potential in the clean energy transition:

#### #1 – Hydrogen has promise

This versatile, clean-burning element has a role to play in carbon reduction and the transition toward lower- and zero-carbon energy production. Hydrogen can help reduce emissions from fossil fuels and heavily polluting industries. Importantly it also has the potential to improve the reliability of renewable energy.

#### In the coming years, we think hydrogen will:

- **Flow through natural gas pipelines.** Some existing pipelines can safely carry a mixture of 5–15 percent hydrogen with natural gas without damaging the infrastructure, according to RBC Capital Markets;
- **Reduce emissions in heavy industries** such as chemicals, steel, iron, and cement production, as well as crude oil refining;
- **Become a key component of local industrial power supply chains** that incorporate wind, solar, and other green energy solutions; and
- **Help to power transportation systems** such as truck fleets, trains, industrial equipment (e.g., forklifts), ferries, tug boats, ships, and airplanes.

Hydrogen demand is currently modest, but appears set to rise as industries look to reduce their carbon footprint. Hydrogen's uses are already expanding into the applications cited above and perhaps will move into even more ambitious applications as the costs of low- and zero-carbon hydrogen production decline.

RBC Capital Markets estimates global demand for pure hydrogen is about 70 million metric tons, with about 95 percent consumed by the oil refining and chemicals industries.

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An additional 45 million metric tons of hydrogen demand comes from mixtures of hydrogen with other gases, mainly used for heat and electricity.

We believe demand for pure hydrogen is expected to increase meaningfully in coming decades, but the forecasts and scenarios vary widely, from a 267 percent increase to a 10-fold increase by 2050. There is even a “theoretical max” demand estimate that is much higher, as the chart below illustrates.

The degree to which hydrogen demand will grow depends on how weak or strong governments’ clean energy and hydrogen policies are, and how coordinated. Importantly, demand will also depend on how much cost improvement occurs through hydrogen innovation relative to competing energy sources.

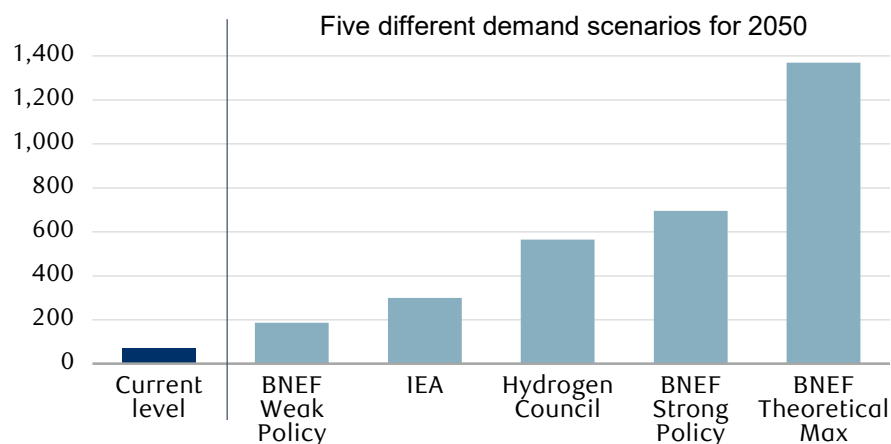
Existing national and multi-national carbon reduction agreements are key factors that could incentivize hydrogen demand growth. But we doubt the Paris Climate Agreement will be the last word on climate and sustainability goals.

In 2020, the EU developed more aggressive goals to decarbonize its economy and, importantly, incorporated hydrogen in its plans. Within the EU, the German government has among the most ambitious hydrogen goals, which is notable because that country is home to the largest industrial firms in the EU.

We think carbon reduction targets in other major economies are likely to be ratcheted up and will serve to expand the uses and demand for hydrogen.

### Demand forecasts vary widely

Potential global demand for hydrogen in 2050 in different scenarios (in millions of metric tons per year)



Note: BNEF “Weak Policy” and “Strong Policy” scenarios depend on how strong and coordinated government decarbonization and hydrogen policies are. The BNEF “Theoretical Max” estimate depends on strong policy plus the adoption of hydrogen by unlikely-to-electrify sectors of the economy. The IEA forecast represents its Sustainable Development Scenario, which it estimates based on goals in the Paris Climate Agreement. The Hydrogen Council is an industry group of more than 100 companies that seeks to accelerate the deployment of hydrogen in order to foster the clean energy transition.

Source - RBC Wealth Management, RBC Capital Markets, BloombergNEF (BNEF), International Energy Agency (IEA), Hydrogen Council

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### #2 – There are hurdles

With every promising or revolutionary aspect of hydrogen’s future role in cleaner energy output, hurdles exist. We think many of them can be overcome, but others seem more daunting. The degree to which such challenges are met will determine just how ubiquitous hydrogen becomes.

The International Energy Agency (IEA) estimates that about 75 percent of hydrogen currently comes from natural gas and 23 percent from coal, the latter with a high carbon footprint. In the future, other means of hydrogen production using electricity derived from wind, solar, hydro, and nuclear energy, will come to represent a greater share of the total.

**As hydrogen production becomes less carbon-intensive, its uses expand, and more production processes become viable, the following challenges will inevitably arise:**

**Storage:** Hydrogen is more difficult to store than fossil fuels because it is less dense (only 15 percent as dense as gasoline), more diffusible (i.e., can spread), and can penetrate and leak through some types of steel and iron and cause them to become brittle.

## Back to school: What is H<sub>2</sub>?

### Hydrogen ...

Is the most abundant element in the universe

Is clean-burning, colorless, and odorless

Has a flame that is invisible to the naked eye

On earth, exists only bonded with other elements (i.e., water H<sub>2</sub>O)

Is the lightest element, so it has low density or mass by volume (only 15% as dense as gasoline)

But it has high energy density (almost 3 times more than diesel or gasoline)—meaning a greater amount of energy stored in its mass

Is an energy carrier, not an energy source

Can store energy, which allows it to function as a battery to complement renewable energy and smooth out intermittent supply and demand mismatches of solar and wind power

Has diffusibility (i.e., it can spread more easily than natural gas)

Can penetrate through porous metals, including some types of steel and iron pipes

Can be stored and transported within certain limitations

Has a combustion potential (auto-ignition temperature) similar to natural gas and much higher than gasoline vapor

Generates no carbon emissions on its own. The amount of carbon emissions involved in hydrogen production depends on the source used to extract it (hydrogen from coal has high emissions; hydrogen from wind power has very low to zero emissions)



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There are four primary methods of storing hydrogen: underground salt caverns, depleted oil and natural gas fields, rock caverns (aquifers), and pressurized containers. Salt caverns are the best-suited of the geological options, according to RBC Capital Markets. But salt caverns are limited geographically. Containers are better-suited for small-scale storage. Companies and the scientific community are working to develop storage tanks for liquefied and solid-state hydrogen using innovative metals.

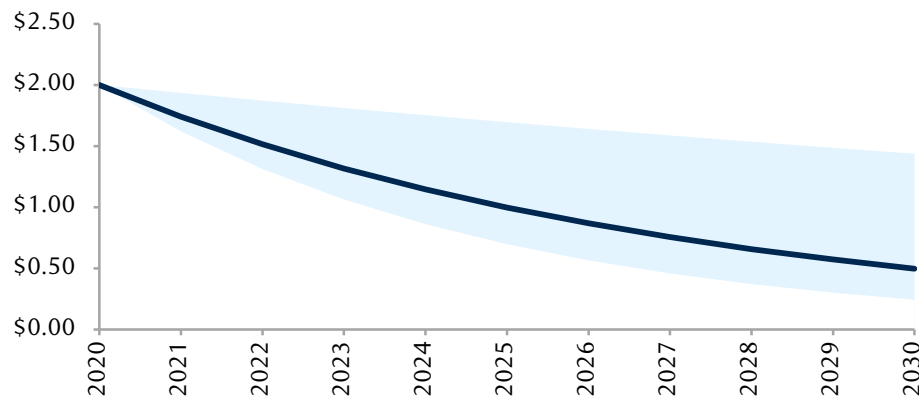
**Transport:** Without modifications, many natural gas pipelines can carry a 5–15 percent blend of hydrogen, RBC Capital Markets estimates, depending on the pipeline’s type of steel. Over time, existing pipelines could be converted to pure hydrogen pipelines, and new hydrogen pipelines could be built, albeit both at a significant cost. Hydrogen’s low density makes it costly to transport by road, rail, or ship. But innovation and carbon reduction incentives should make this more feasible over time.

**Cost:** Large-scale local supply chains will likely be the most cost-effective means to deliver hydrogen to industrial users, according to BloombergNEF (BNEF). Its analysts estimate the cost of “green hydrogen” (i.e., hydrogen produced with renewable power sources having almost zero carbon emissions) could decline by 85 percent to under \$1 per kilogram in many parts of the world by 2050, an accelerated pace compared to its own estimate just one year ago. This is among the most aggressive forecasts.

Regardless of the pace of green energy efficiencies, we think electrolyser equipment will play a key role in the cost equation. That equipment uses electricity from wind, solar, hydro, or nuclear power to separate hydrogen from oxygen in water, enabling the hydrogen to generate power via fuel cells, internal combustion engines, turbines, and other processes. RBC Capital Markets expects the capital cost of hydrogen electrolysers to fall dramatically through 2030, as the chart below illustrates. The drawback is that the electrolysis process is highly water-intensive. Not all countries or locales have the necessary water supplies; those that do are best equipped to incorporate electrolysis processes.

### Potential capital cost declines of electrolysers (per kilogram of H<sub>2</sub>)

Electrolysers are the equipment used to produce hydrogen from wind, solar, hydro, and nuclear power. The lower the cost of this equipment, the more likely hydrogen will be in demand.



**Bear scenario:** The upper part of the light blue shaded area, where the costs are highest

**Base scenario:** The dark blue line

**Bull scenario:** The lower part of the light blue shaded area, where the costs are lowest

The “Bear scenario” assumes 22.5 gigawatt total capacity installed, 13% learning rate. The “Base scenario” assumes 90 gigawatt total capacity installed, 13% learning rate. The “Bull scenario” assumes 90 gigawatt capacity installed, 19% learning rate. Data assumes a 50% load factor.

Source - RBC Capital Markets estimates, Hydrogen Council

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### #3 – It's not one size fits all

There will be—and should be—regional differences in the uses and export of hydrogen, especially over the next 5–10 years. While many governments' long-term goals will be to derive the bulk of hydrogen production from clean energy sources—aka green hydrogen—the main “colors” or types of hydrogen that dominate in one country or region likely won't be the best fit for others in the early years of this transition.

Leaders in natural gas supplies, such as the U.S., Russia, Qatar, and Canada, may initially tilt toward producing a greater share of blue and turquoise hydrogen—both of which can be derived from natural gas—than countries without such abundant resources.

This is not green hydrogen *per se*, but it can reduce carbon emissions nonetheless. According to RBC Capital Markets, blue hydrogen is four times less carbon-intensive than gray hydrogen, which is predominantly produced today. Turquoise hydrogen is even less carbon-intensive. RBC Capital Markets energy analysts wrote, “We believe natural gas may become a bridge fuel that helps green hydrogen become a reality.”

### The hydrogen rainbow

The major types of hydrogen classified by colors

| Types of H <sub>2</sub> | Production source (feedstock) and select production processes   |
|-------------------------|---|
| Brown                   | From coal; traditionally has not involved carbon capture and storage (CCS) but can through coal gasification              |
| Gray                    | From natural gas through thermochemical conversion  |
| Blue                    | From natural gas via steam reforming; uses carbon capture and storage (CCS) to minimize CO <sub>2</sub> emissions         |
| Turquoise               | From natural gas via methane pyrolysis; H <sub>2</sub> and solid carbon are the outputs, both of which have uses          |
| Yellow                  | From nuclear power via electrolysis and other methods   |
| Green                   | From renewable electricity (solar, wind, and hydro) via electrolysis of water; breaks down water into hydrogen and oxygen |

Source - RBC Wealth Management, RBC Capital Markets, U.S. Department of Energy, EWE AG, World Nuclear Association

Countries that already have a relatively higher proportion of renewable power supplies, such as the UK, Sweden, Denmark, and Spain, may be able to capitalize on green hydrogen production more quickly than countries still in the early stages of such a buildout.

China could, indirectly or directly, eventually become a leader in green hydrogen production. In addition to building out significant renewable power resources, China is already a leader in electrolysis equipment manufacturing which is essential for green hydrogen production. While Europe currently leads on electrolyser innovation, China produces the cheapest electrolysers in the world.

## MONTHLY FOCUS

Hydrogen: More than just talk

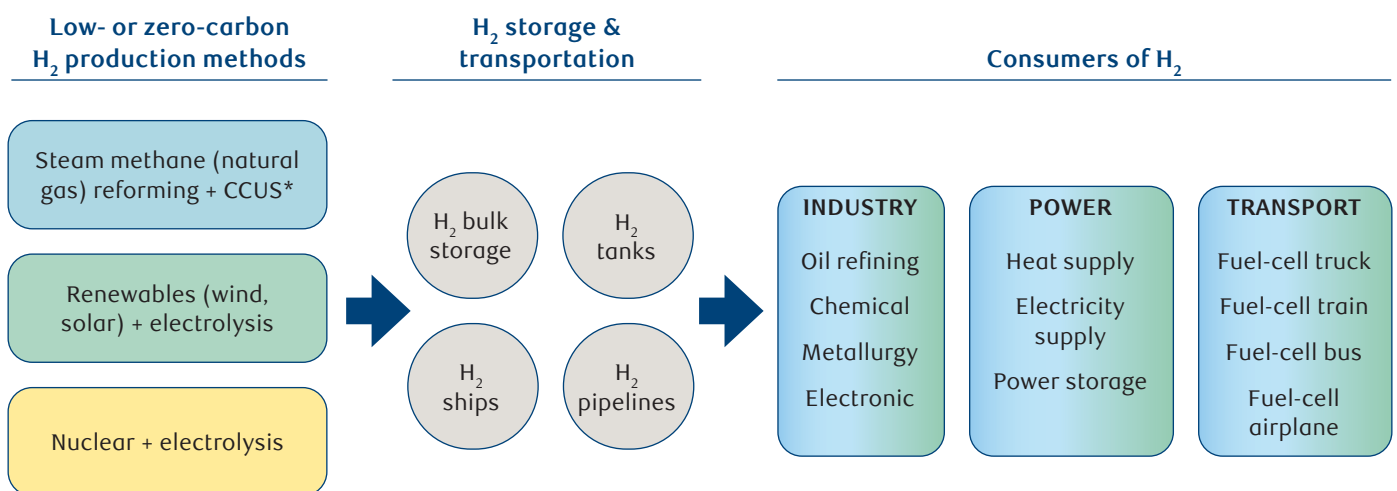
Even within countries, there will be geographic differences. For example, the Canadian provinces of British Columbia (BC) and Alberta have relatively robust wind and solar resources alongside abundant natural gas supplies and infrastructure. This makes BC and Alberta uniquely positioned to provide green hydrogen to local industries and export it to other parts of Canada and the U.S., and to develop blue and turquoise natural gas-based hydrogen for regional use and export.

There is a debate among experts about just how fast the various types of hydrogen will evolve and which will lead. Estimates are in flux, with some seeing a predominant role for blue and turquoise hydrogen for many years, but others such as BNEF seeing green hydrogen moving to the fore more quickly. An important determinant will be how rapidly the two major platforms for future hydrogen development are adopted. In some respects, there are competing interests between the two.

- **Large-scale transportation networks:** Hydrogen would be shipped by pipeline from production centers to industrial consumers, including over great distances. This model would be akin to today’s oil and natural gas distribution channels.
- **Localized distribution networks:** Hydrogen production and consumption would occur within regions and countries—the closer to end-user demand the better.

The large-scale hydrogen transportation platform is a long-range and much more expensive approach in terms of infrastructure buildout, whereas the localized hydrogen networks could have near-term cost advantages and potential, but lack scale. We see advantages for the latter.

### Hydrogen supply chain from production to consumers



\*CCUS stands for “Carbon capture, utilization, and storage”  
Source - RBC Wealth Management, Rosatom Global



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## MONTHLY FOCUS

*Hydrogen: More than just talk*

### #4 – Government policies and innovation will play outsized roles

BNEF estimates that building on existing piecemeal regulatory approaches with support from governments will enable hydrogen to meet seven percent of global energy needs by 2050 compared to the low-single digits today—not an insignificant proportion.

For hydrogen to take off over the longer term and become a much greater component of total energy supply, significantly more will have to be done. Strong and coordinated government regulations and incentives, and significant government and private sector funding would be necessary to build scale and advance technologies. Corporations will need to be proactive and seize the opportunity. The price tag is high, and we are already starting to see mismatches between decarbonization goals and incremental realized outcomes.

BNEF analysts estimate expenditures of \$11 trillion in hydrogen production, storage, and transport infrastructure would be necessary to push hydrogen's role up to 24 percent of global energy needs by 2050. This scenario would also require a significant, separate investment in renewable wind and solar energy, which hydrogen production would leverage.

Without substantial government support and coordinated regulation—and corporate enthusiasm—it's doubtful the private sector hydrogen research and development, innovation, and investment will take place on a grand scale. But ubiquitous hydrogen deployment is not required to push incremental hydrogen demand higher and derive decarbonization benefits.

### #5 – Key industries are innovating

Investment opportunities in hydrogen are not yet “clear” so to speak—it's still early. But they are forming in four broad categories:

- **Heavy industry applications**, particularly in the chemicals, steel, other heavy metals, and cement industries where carbon emission reduction will be essential to achieve global goals;
- **Oil refining and natural gas industry uses**, including pipeline companies;
- **Hydrogen for local industrial supply chains and power generation** based on electrolysis from wind, solar, hydro, and nuclear power sources; and
- **Transportation industry innovations.**

Efforts in the transportation industry are garnering a relatively large share of media attention. Companies, startups, and research institutes are looking into and testing hydrogen-based fuel cells and internal combustion engines to power medium- and long-haul heavy-payload truck fleets, commuter and freight trains, industrial equipment (e.g., forklifts), ferries, tug boats, ships, and airplanes.

For example, Canadian Pacific Railway plans to develop North America's first locomotive based on battery power and hydrogen fuel cells. In

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## MONTHLY FOCUS

*Hydrogen: More than just talk*

Europe, Austria recently placed Alstom's hydrogen-powered passenger train into regular service. Startup ZeroAvia, a UK-based firm, is developing a single-propeller airplane that can operate on an electric motor driven by hydrogen fuel cells. Europe's Airbus is testing hydrogen-based power applications as well. Kawasaki Heavy Industries conducted the world's first successful trial of transporting liquefied hydrogen by ship in October 2020. This effort is part of a long-term, landmark agreement between Japan and Australia to deliver liquid hydrogen produced from Australian coal via ship to Japan. Norway-based Nel, the world's largest producer of hydrogen electrolyzers, was recently awarded a contract to build hydrogen fueling stations for light-duty fuel cell vehicles in Quebec, Canada. Nel also supplies fueling equipment and electrolyzers for hydrogen-based truck and bus fleet infrastructure in the U.S., China, and Europe.

**Transportation industry sizzle aside, we think the potentially more consequential innovations and uses of hydrogen in the next 5–10 years will take place in carbon-intensive heavy industries—steel, chemicals, natural gas, and power generation.**

Linde, a UK-based multinational formed from a merger with U.S.-based Praxair, has already built more than 80 hydrogen electrolysis plants mainly used by traditionally carbon-heavy industries.

Some of the most ground-breaking innovations are coming in the steel industry. Linde, in partnership with Sweden-based steel maker Ovako, successfully replaced liquefied natural gas with hydrogen as feedstock in the production process—a first for the industry. This reduced carbon emissions without any negative impact on the steel's quality. German steelmaker ThyssenKrupp and Japan's Nippon Steel are attempting to make “zero-carbon steel” using green hydrogen derived from solar and wind electricity through the electrolysis process, instead of the heavy-carbon-intensive steel manufacturing process of burning “met” coal at high temperatures.

BASF, the world's largest chemicals company, has built a test plant that will be used to determine if low-carbon hydrogen using methane pyrolysis can succeed at an industrial scale. This process splits biomethane (natural gas) into two components: hydrogen and solid carbon. The hydrogen could be used to generate power for a variety of uses, while the solid carbon could be used in heavy metals production such as aluminum and steel, or for battery materials. Other firms are working on methane pyrolysis as well. We think this technology has promise.

There are a number of hydrogen initiatives in the power industry. The H21 project, a UK government partnership with Norwegian energy firm Equinor and UK gas distributor Cadent, would bring a 12.5 gigawatt hydrogen-based power plant to Northern England. In the U.S., NextEra Energy Inc. seeks to build its first green hydrogen power plant in Florida, which will use a 20 megawatt electrolyser based on solar power. Entergy is partnering with Mitsubishi Power to bring hybrid hydrogen- and natural gas-based power to Texas and other states in the region. In Ohio, the Long Ridge Energy Terminal is slated to become a carbon-free hydrogen production facility. It will initially run on a blend of hydrogen and methane (natural gas) based

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## MONTHLY FOCUS

*Hydrogen: More than just talk*

on General Electric turbines, and then would ultimately transition to 100 percent hydrogen.

### **Opportunity**

Hydrogen has rapidly become more than just talk. Many businesses ranging from startups to major industrials have committed to an accelerated increase in production and to innovative applications. Governments are committing to even more stringent and challenging emission reduction targets for 2050. The significant drop in renewable electricity costs and dramatic increase in renewable power production is facilitating and opening the door to hydrogen as a valuable complementary clean technology, in our opinion. While the costs for building out the related industrial infrastructure may be high, we think the potential for job and wealth creation is compelling.

For hydrogen-related investments, we would focus on opportunities that are likely to find their way to market in the next 5–10 years and are not as dependent on substantial, coordinated long-term government subsidies that have yet to be designated or allocated.

## GLOBAL Equity

### Jim Allworth

Vancouver, Canada  
jim.allworth@rbc.com

#### Equity views

| Region             | Current |
|--------------------|---------|
| Global             | +       |
| United States      | +       |
| Canada             | =       |
| Continental Europe | =       |
| United Kingdom     | =       |
| Asia (ex Japan)    | +       |
| Japan              | =       |

+ Overweight; = Market Weight; – Underweight  
Source - RBC Wealth Management

## Gathering speed

The U.S. and Canadian economies are powering ahead. Q1 GDP growth for the U.S. came in at a very strong 6.4% (and we suspect may be eventually revised higher). The Canadian economy looks to be keeping pace and we think it will do so over the full year. Consumer spending, by far the largest component in both economies, has been leading the way. But capital spending by business looks to be taking off too—non-residential capex in the U.S. grew by a chunky 9.9% in Q1 following an even stronger Q4 last year. Importantly, equipment and software spending advanced at a startling 26% annual rate.

Meanwhile, with new orders running at a blistering pace for both manufacturing and services, inventories too low despite efforts to replenish, and economies not yet fully reopened, this powerful GDP momentum is likely to extend through 2021 and well into 2022, in our opinion. An eventual U.S. infrastructure spending initiative will add a positive impetus for several years beyond 2021.

With the Conference Board’s Measure of CEO Confidence at a 17-year high, quarterly earnings and forward guidance are likely to remain upbeat. And analysts’ earnings estimates, on balance, are unlikely to be revised lower anytime soon.

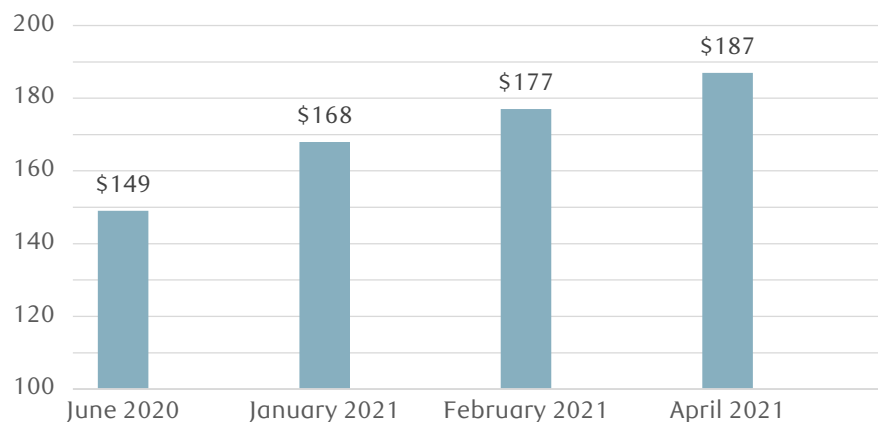
While Europe and the UK have lagged North America mostly due to pandemic-related lockdowns and Brexit confusion, consumer and business confidence are on the rise and imminent reopenings are likely to boost sentiment further. The comeback in the tourism sector—important to the UK, France, Spain, and Italy—should be a big addition to GDP in the second half of this year and all of next.

China’s recovery continued through Q1, albeit at a somewhat slower pace. Monetary policy tightening has already produced some volatility in debt markets but is unlikely, in our opinion, to seriously alter the GDP trajectory in that country.

Strong economic and earnings momentum, robustly positive consumer and business confidence, and policy still set at “supportive” combine to produce a constructive outlook for equities. The major trend is likely to remain upward as long as the outlook for the economy remains positive. Corrections can arrive at any time, but we believe that concern about higher-than-normal valuations is very unlikely to be the trigger.

We recommend a global balanced portfolio be moderately Overweight equities.

#### Evolution of our 2021 S&P 500 earnings estimate



Source - RBC Wealth Management, RBC Capital Markets

GLOBAL  
Fixed income

**Atul Bhatia, CFA**

Minneapolis, United States  
atul.bhatia@rbc.com

# The calm before the calm?

Treasury yields declined in April despite a flurry of positive economic data, including strong gains in nonfarm payrolls and retail sales. With vaccination rates in the U.S. moving higher, conditions point toward continued strong growth in the second and third quarters.

Rising bond prices are atypical against a strong economic backdrop, but we see several reasons for the recent demand. One is the high rate of global infections, which has led to some limited border closures. The absolute level of Treasury yields—which even after currency hedging is higher than that of many foreign government bonds—has also sparked demand from overseas investors. Another factor is the still-low rate of inflation: although retail sales were up 9.8% in March from the prior month, March’s core consumer prices were only 1.6% higher than 2020.

The recent strong data is unlikely to change monetary policy in the near term. The Fed has consistently guided to accommodative policy until employment has recovered and inflation is well-established. This stance is generally in line with other developed market central banks. The head of the European Central Bank,

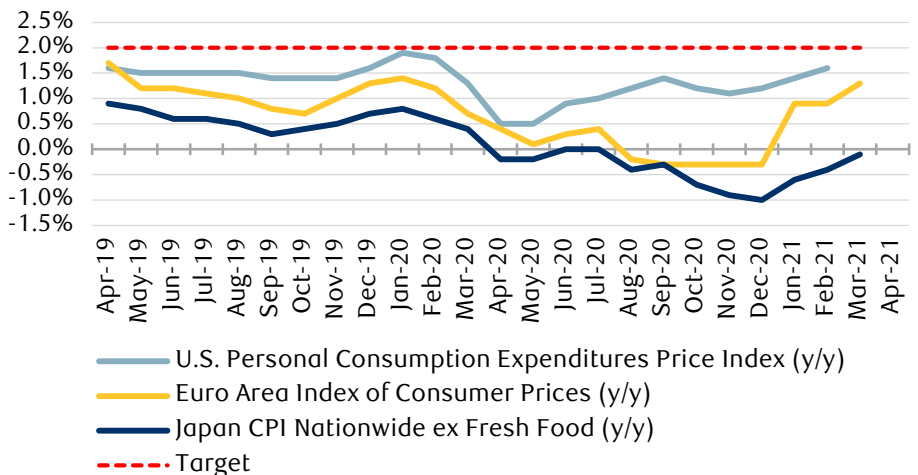
for instance, said that it is premature to even discuss scaling back stimulus, and the Bank of Japan maintained its aggressive policy stance at its April 27 meeting. The Bank of Canada did recently cut the amount of its bond purchases, but it remains an outlier among G7 central banks.

With Fed policy unlikely to change and largely priced in, investor emphasis in the U.S. is shifting to fiscal policy that is more difficult to predict. The Biden infrastructure plan equates to nearly 10% of GDP but faces an uncertain future in Congress. Similarly, the administration has proposed corporate and capital gains tax changes that, if implemented, may potentially impact future individual and corporate investment. We believe investor uncertainty around these proposals—particularly the changes to tax policy—could provide additional temporary support to bond prices.

We continue to believe in the growth story and expect rates to rise over time. In the U.S., we believe yields on the 10-year Treasury will likely be near 2% by year end. Were 30-year yields to reach 2.5% over that period, we would view them as potentially attractive for the long term.

Despite recent strong data, inflation is still running below the target of 2%. Accommodative policy will likely remain until inflation is well established.

U.S., Europe, and Japan all below target on preferred inflation measure



Source - RBC Wealth Management, Bloomberg; U.S. data through 2/28/21 & EU/Japan data through 3/31/21

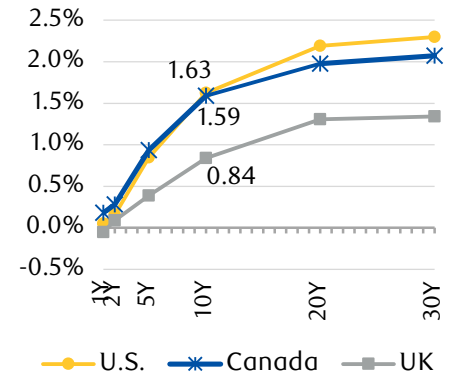
## GLOBAL FIXED INCOME

### Fixed income views

| Region             | Gov't bonds | Corp. credit | Duration |
|--------------------|-------------|--------------|----------|
| Global             | =           | +            | 5-7 yr   |
| United States      | =           | +            | 5-7 yr   |
| Canada             | =           | =            | 5-7 yr   |
| Continental Europe | =           | =            | 5-7 yr   |
| United Kingdom     | -           | =            | 3-5 yr   |

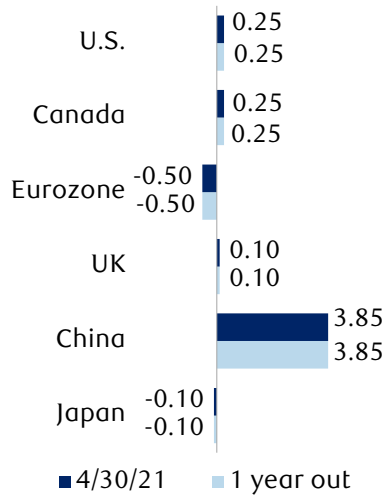
+ Overweight; = Market Weight; - Underweight  
 Source - RBC Wealth Management

### Sovereign yield curves



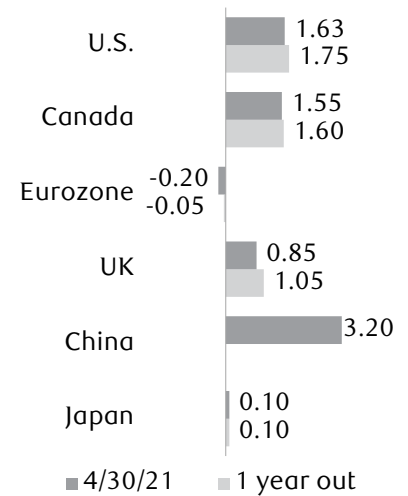
Source - Bloomberg; data through 4/30/21

### Central bank rate (%)



\*1-yr base lending rate for working capital, PBoC  
 Source - RBC Investment Strategy Committee, RBC Capital Markets forecasts, Global Portfolio Advisory Committee, RBC Global Asset Management

### 10-year rate (%)



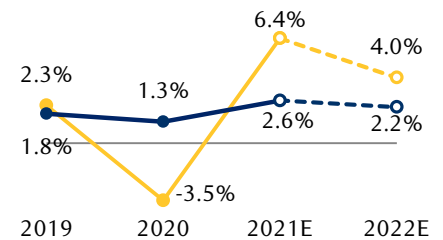
Note: Eurozone utilizes German Bunds.  
 Source - RBC Investment Strategy Committee, Global Portfolio Advisory Committee, RBC Global Asset Management

# KEY Forecasts

Real GDP growth Inflation rate

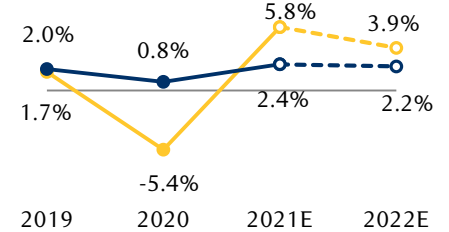
## United States: Housing boom

Economic data broadly positive amid vaccination rollout. ISM indexes firmly in expansion territory. New orders positive, inventories too low. Unemployment rate down to 6%, weekly unemployment claims falling. Strong payroll growth will result in all jobs replaced by early 2022. Home prices at 15-year high on record low supply. Core inflation barely below the Fed's 2% target at 1.8% y/y. Near-term surge underway, but Fed policy unlikely to change.



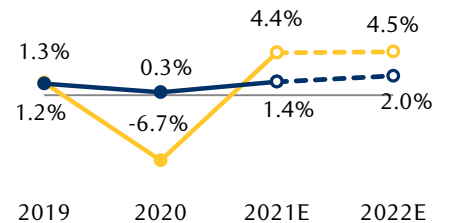
## Canada: BoC sees brightening economic outlook

The BoC advanced the timeline to full economic recovery from the effects of the pandemic. Growth expectations up more than 2% to 6.5% for 2021, and inflation projected to reach 2% target by late 2022. The committee tapered asset purchases from CA\$4 billion to CA\$3 billion per week. Housing market worryingly strong as demand well ahead of supply. Unemployment rate at 7.5%. Third wave lockdowns temporarily dampening employment growth.



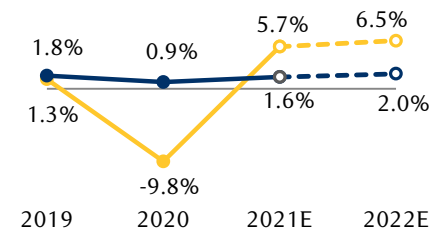
## Eurozone: Manufacturing jumps to new record

Double-dip recession arrived with Q1 negative GDP growth report. Largely a result of big hit to important services sector from widespread shutdown in response to third wave. Eurozone manufacturing hit a record high mostly due to continued strength in Germany's output. European Central Bank kept its very stimulative monetary policy unchanged. After a slow start, vaccinations have picked up, which should lead to gradual reopenings throughout May. Tourism rebound expected in H2.



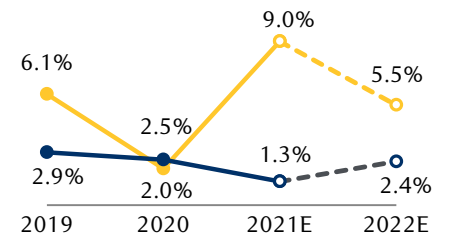
## UK: Expecting faster growth

Bank of England (BoE) Deputy Governor Ben Broadbent recently said he expects to see "very rapid economic growth at least over the next couple of quarters." Consumers expected to spend as much as 5% of savings banked during pandemic. Manufacturing and industrial output climbed with transport equipment as well as computer, electrical, and optical equipment leading the way. Pent-up demand drove stronger-than-expected retail sales.



## China: Domestic slowdown

China's official and Caixin PMIs indicate domestic economy is slowing while external demand remains strong. Construction indicators show infrastructure investment has weakened in response to government efforts to rein in lending. The dynamic phase of the recovery from the pandemic appears to be over with slower growth projected going forward as the government deals with distortions in the debt market.



## Japan: Consumer slump following shutdowns

GDP has been recovering on the back of very strong exports and manufacturing. Consumer and business confidence on the rise. Despite these positives, Q1 GDP expected to retreat as COVID-19-related shutdowns hit consumer spending. Recovery expected to pick up speed late in Q2. Bank of Japan to maintain accommodative policy but now expects inflation won't reach 2% target before 2024.

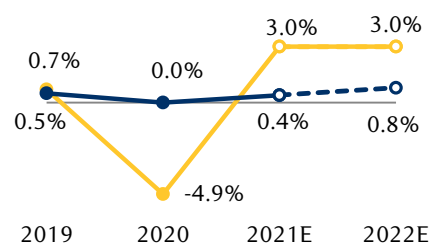


Chart source - RBC Investment Strategy Committee, RBC Capital Markets, Global Portfolio Advisory Committee, Bloomberg consensus estimates

## MARKET Scorecard

Data as of April 30, 2021

### Equities

Global equity markets posted positive returns with the exception of the Nikkei 225 and India Sensex in April, led by the S&P 500 and Nasdaq.

### Bond yields

Sovereign bond yields were mixed in April, with 10-year sovereigns posting gains for the month while 2-year bond yields were mostly higher.

### Commodities

Commodity prices ticked higher in April with the exception of uranium, which saw prices weaken.

### Currencies

The U.S. dollar weakened against other major currencies amid increased stimulus spending and inflation risk.

Equity returns do not include dividends, except for the Brazilian Ibovespa. Equity performance and bond yields in local currencies. U.S. Dollar Index measures USD vs. six major currencies. Currency rates reflect market convention (CAD/USD is the exception). Currency returns quoted in terms of the first currency in each pairing.

Examples of how to interpret currency data: CAD/USD 0.81 means 1 Canadian dollar will buy 0.81 U.S. dollar. CAD/USD 13.5% return means the Canadian dollar has risen 13.5% vs. the U.S. dollar during the past 12 months. USD/JPY 109.31 means 1 U.S. dollar will buy 109.31 yen. USD/JPY 2.0% return means the U.S. dollar has risen 2.0% vs. the yen during the past 12 months.

Source - RBC Wealth Management, RBC Capital Markets, Bloomberg; data through 4/30/21

| Index (local currency)  | Level      | 1 month | YTD   | 12 month |
|-------------------------|------------|---------|-------|----------|
| S&P 500                 | 4,181.17   | 5.2%    | 11.3% | 43.6%    |
| Dow Industrials (DJIA)  | 33,874.85  | 2.7%    | 10.7% | 39.1%    |
| Nasdaq                  | 13,962.68  | 5.4%    | 8.3%  | 57.1%    |
| Russell 2000            | 2,266.45   | 2.1%    | 14.8% | 72.9%    |
| S&P/TSX Comp            | 19,108.33  | 2.2%    | 9.6%  | 29.3%    |
| FTSE All-Share          | 3,983.85   | 4.0%    | 8.4%  | 22.1%    |
| STOXX Europe 600        | 437.39     | 1.8%    | 9.6%  | 28.6%    |
| EURO STOXX 50           | 3,974.74   | 1.4%    | 11.9% | 35.8%    |
| Hang Seng               | 28,724.88  | 1.2%    | 5.5%  | 16.6%    |
| Shanghai Comp           | 3,446.86   | 0.1%    | -0.8% | 20.5%    |
| Nikkei 225              | 28,812.63  | -1.3%   | 5.0%  | 42.7%    |
| India Sensex            | 48,782.36  | -1.5%   | 2.2%  | 44.7%    |
| Singapore Straits Times | 3,218.27   | 1.7%    | 13.2% | 22.6%    |
| Brazil Ibovespa         | 118,893.80 | 1.9%    | -0.1% | 47.7%    |
| Mexican Bolsa IPC       | 48,009.72  | 1.6%    | 8.9%  | 31.6%    |

| Bond yields    | 4/30/21 | 3/31/21 | 4/30/20 | 12 mo. chg |
|----------------|---------|---------|---------|------------|
| U.S. 2-Yr Tsy  | 0.158%  | 0.160%  | 0.196%  | -0.04%     |
| U.S. 10-Yr Tsy | 1.626%  | 1.740%  | 0.639%  | 0.99%      |
| Canada 2-Yr    | 0.301%  | 0.226%  | 0.312%  | -0.01%     |
| Canada 10-Yr   | 1.546%  | 1.558%  | 0.547%  | 1.00%      |
| UK 2-Yr        | 0.080%  | 0.104%  | 0.017%  | 0.06%      |
| UK 10-Yr       | 0.842%  | 0.845%  | 0.231%  | 0.61%      |
| Germany 2-Yr   | -0.682% | -0.601% | -0.760% | 0.08%      |
| Germany 10-Yr  | -0.202% | -0.185% | -0.586% | 0.38%      |

| Commodities (USD)      | Price    | 1 month | YTD    | 12 month |
|------------------------|----------|---------|--------|----------|
| Gold (spot \$/oz)      | 1,769.13 | 3.6%    | -6.8%  | 4.9%     |
| Silver (spot \$/oz)    | 25.92    | 6.1%    | -1.8%  | 73.1%    |
| Copper (\$/metric ton) | 6,486.50 | 11.8%   | 26.8%  | 90.5%    |
| Uranium (\$/lb)        | 20.90    | -0.5%   | -12.6% | -7.7%    |
| Oil (WTI spot/bbl)     | 63.58    | 7.5%    | 31.0%  | 237.5%   |
| Oil (Brent spot/bbl)   | 67.25    | 5.8%    | 29.8%  | 166.1%   |
| Natural Gas (\$/mmBtu) | 2.93     | 12.4%   | 15.4%  | 50.4%    |
| Agriculture Index      | 273.20   | 13.7%   | 19.2%  | 66.4%    |

| Currencies        | Rate     | 1 month | YTD   | 12 month |
|-------------------|----------|---------|-------|----------|
| U.S. Dollar Index | 91.2800  | -2.1%   | 1.5%  | -7.8%    |
| CAD/USD           | 0.8137   | 2.2%    | 3.6%  | 13.5%    |
| USD/CAD           | 1.2287   | -2.2%   | -3.4% | -11.9%   |
| EUR/USD           | 1.2020   | 2.5%    | -1.6% | 9.7%     |
| GBP/USD           | 1.3822   | 0.3%    | 1.1%  | 9.8%     |
| AUD/USD           | 0.7716   | 1.6%    | 0.3%  | 18.5%    |
| USD/JPY           | 109.3100 | -1.3%   | 5.9%  | 2.0%     |
| EUR/JPY           | 131.4000 | 1.2%    | 4.1%  | 11.9%    |
| EUR/GBP           | 0.8701   | 2.2%    | -2.6% | 0.0%     |
| EUR/CHF           | 1.0978   | -0.8%   | 1.5%  | 3.8%     |
| USD/SGD           | 1.3308   | -1.0%   | 0.7%  | -5.6%    |
| USD/CNY           | 6.4749   | -1.2%   | -0.8% | -8.3%    |
| USD/MXN           | 20.2462  | -0.9%   | 1.7%  | -16.2%   |
| USD/BRL           | 5.4376   | -3.5%   | 4.6%  | -0.9%    |



## Research resources

This document is produced by the Global Portfolio Advisory Committee within RBC Wealth Management's Portfolio Advisory Group. The RBC Wealth Management Portfolio Advisory Group provides support related to asset allocation and portfolio construction for the firm's investment advisors / financial advisors who are engaged in assembling portfolios incorporating individual marketable securities.

The Global Portfolio Advisory Committee leverages the broad market outlook as developed by the RBC Investment

Strategy Committee (RISC), providing additional tactical and thematic support utilizing research from the RISC, RBC Capital Markets, and third-party resources.

The RISC consists of senior investment professionals drawn from individual, client-focused business units within RBC, including the Portfolio Advisory Group. The RISC builds a broad global investment outlook and develops specific guidelines that can be used to manage portfolios. The RISC is chaired by Daniel Chornous, CFA, Chief Investment Officer of RBC Global Asset Management Inc.

### Global Portfolio Advisory Committee members

**Jim Allworth** – Co-chair  
Investment Strategist, RBC Dominion Securities Inc.

**Kelly Bogdanova** – Co-chair  
Portfolio Analyst, RBC Wealth Management Portfolio Advisory Group U.S., RBC Capital Markets, LLC

**Frédérique Carrier** – Co-chair  
Managing Director & Head of Investment Strategies, RBC Europe Limited

**Mark Bayko, CFA** – Head, Portfolio Management, RBC Dominion Securities Inc.

**Janet Engels** – Head, Portfolio Advisory Group U.S., RBC Wealth Management, RBC Capital Markets, LLC

**Thomas Garretson, CFA** – Fixed Income Senior Portfolio Strategist, RBC Wealth Management Portfolio Advisory Group, RBC Capital Markets, LLC

**Ryan Harder** – Fixed Income Portfolio Advisor, Portfolio Advisory Group, RBC Dominion Securities Inc.

**Patrick McAllister, CFA** – Manager, Equity Advisory & Portfolio Management, Portfolio Advisory Group, RBC Dominion Securities Inc.

**Alan Robinson** – Portfolio Analyst, RBC Wealth Management Portfolio Advisory Group – U.S. Equities, RBC Capital Markets, LLC

**Michael Schuette, CFA** – Multi-Asset Portfolio Strategist, RBC Wealth Management Portfolio Advisory Group – U.S., RBC Capital Markets, LLC

**David Storm, CFA, CAIA** – Chief Investment Officer BI & Asia, RBC Europe Limited

**Tat Wai Toh** – Head of Portfolio Management, BI & Asia, Royal Bank of Canada, Singapore Branch

**Joseph Wu, CFA** – Portfolio Manager, Multi-Asset Strategy, RBC Dominion Securities Inc.

### Additional Global Insight contributors

**Atul Bhatia, CFA** – Fixed Income Portfolio Strategist, RBC Wealth Management Portfolio Advisory Group, RBC Capital Markets, LLC

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|-----------------------|-------|---------|--|---------|
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